

PONTRYAGIN, L. S.

Pontryagin, L. S. On the classification of four-dimensional
manifolds. Uspehi Matem. Nauk (N.S.) 4, no. 4(32),
157-158 (1949). (Russian)

Following a statement of new results, the author remarks
that more general results than his have just appeared in a
paper by Whitehead [Comment. Math. Helv. 22, 48-92
(1949); these Rev. 10, 559]. L. Zippin (Flushing, N. Y.).

Source: Mathematical Reviews,

Vol. 11 No. 3

Pontryagin, L. S.

Pontryagin, L. S. Some topological invariants of closed
Riemannian manifolds. Izvestiya Akad. Nauk SSSR.
Ser. Mat. 13, 125-162 (1949). (Russian)

This is the detailed exposition of results announced earlier [C. R. (Doklady) Acad. Sci. URSS (N.S.) 43, 91-94 (1944); these Rev. 6, 183]. The author states that "the paper, in so far as possible, translates into the language of differential forms the contents of an earlier work" [Mat. Sbornik, N.S. 21(63), 233-284 (1947); these Rev. 9, 243]. A somewhat general introduction is followed [in § 1] by an exposition of the tensor theory of homology on manifolds. In § 2 the author treats the space $I(k, l)$ of k -dimensional planes through the origin of a Euclidean R^{k+l} as a homogeneous space under the action of the group G of proper orthogonal transformations of R^{k+l} into itself, the origin being fixed. Here he derives all closed invariant fields over

$I(k, l)$ of order not exceeding k , on the assumption that $l \geq k+1$. These fields give rise [in § 3] to the "characteristic fields" on a manifold M^k , provided that M^k is mapped into R^{k+l} regularly (in the sense of Whitney). It is shown that the characteristic fields may be expressed in terms of the Riemann metric tensor associated with M^k through its regular imbedding in R^{k+l} ; but the fields are independent (to within homology) of the particular regular imbedding, and independent also of the number l . To these fields (of order r) there correspond [in § 4] certain earlier defined characteristic cycles (of dimension $k-r$). Thus, if P denotes the field, $X(P)$ the associated cycle, and if Y is an r -dimensional integral-coefficient cycle on M^k , the correspondence is given by the fact that the incidence number of the cycle $X(P)$ and the cycle Y is measured by the integral over Y of the field P : $\int P = I(X(P), Y)$. The cycle $X(P)$ may be expressed linearly in terms of certain basic characteristic cycles, and the remainder of the paper [§§ 4 and 5] is concerned with integral formulas for the coefficients of this expansion. Here the author also derives the Gauss-Bonnet formula [reference to Chern, Ann. of Math. (2) 45, 747-752 (1944); these Rev. 6, 106, but none to Chern, Proc. Nat. Acad. Sci. U.S.A. 30, 269-273 (1944); these Rev. 6, 106, which is closely related to the present paper].

L. Zippin (Flushing, N. Y.)

Pontryagin, L. S.

Pontryagin, L. S. On a connection between homology and
homotopy. Izvestiya Akad. Nauk SSSR, Ser. Mat. 13,
193-200 (1949). (Russian)

This paper is devoted to the proof of the following result, which was stated as a lemma without proof in a previous note by the author [C. R. (Doklady) Acad. Sci. URSS (N.S.) 34, 35-37 (1942); these Rev. 4, 249]. Let $\varphi: L \rightarrow K$ be a continuous map of an n -dimensional polyhedron L into a connected, simply connected, polyhedron K . Then there exists a map $\psi: L \rightarrow K$ homotopic to φ such that $\psi(L)$ is contained in the $(n-1)$ -dimensional skeleton of K if and only if the induced homomorphisms $\varphi_*: H_*(L) \rightarrow H_*(K)$ are trivial with integers and integers mod m ($m = 2, 3, \dots$) for coefficients of the homology groups H_* . The proof breaks up into two cases, depending on whether $n > 2$ or $n = 2$. The author observes that if the homomorphism $\varphi_*: H_{n-1}(L) \rightarrow H_{n-1}(K)$ is also trivial for the above listed coefficient groups, we cannot conclude that φ is homotopic to a map ψ of L into the $(n-2)$ -skeleton of K . Counterexample: the Hopf map of S^3 on S^1 , $n=3$. Also, the condition that K be simply connected cannot be omitted as is shown by the example $L = S^n$, $K =$ real projective n -space (n even), φ the two-fold covering map.

R. H. Fox and W. S. Massey (Princeton, N. J.).

Sources: Mathematical Reviews, 1950 Vol 11 No. 2

Bourrygin, L. S. The homotopy group $\pi_{n+1}(K_n)$ ($n \geq 2$) of dimension $n+1$ of a connected finite polyhedron K_n of arbitrary dimension whose fundamental group and Betti groups of dimensions $2, \dots, n-1$ are trivial. Doklady Akad. Nauk SSSR (N.S.) 65, 797-800 (1949) (Russian).

Let K_n ($n \geq 1$) be a finite connected polyhedron whose homotopy groups $\pi_r(K_n)$ are trivial for $r = n+1, n, \dots, 1$, and let $\Phi: \pi_r(K_n) \rightarrow H_r(K_n)$ ($r = 1, 2, \dots$) denote the natural homomorphism of the homotopy groups into the integral homology groups. According to a well-known theorem of Hurewicz, Φ^* is an isomorphism onto it is also known that Φ^{r+1} is a homomorphism onto; let $\pi_{n+1}(K_n)$ denote the kernel of Φ^{n+1} . The author determines generators and relations for $\pi_{n+1}(K_n)$. In case $n=2$, this requires a knowledge of the homotopy and cohomology groups and cup products with integers and integers mod m ($m=2, 3, \dots$) for coefficients and the "Pontryagin squares" introduced by the author for this purpose in a previous note [C. R. (Dokady) Acad. Sci. URSS (N.S.) 34, 35-37 (1942); these Rev. 4, 249; cf. also J. H. C. Whitehead, Comment. Math. Helv. 22, 48-92 (1949); these Rev. 10, 555].

For the case $n > 2$, a knowledge of the homology and cohomology groups with integers and integers mod 2 for coefficients and the cup¹ products of Steenrod [Ann. of Math. (2) 45, 290-320 (1947); these Rev. 9, 154] for $i < n-2$ is required. The result for this case has been obtained independently by J. H. C. Whitehead [Ann. Soc. Polon. Math. 21 (1943), 176-186 (1949); these Rev. 11, 48]. G. W. Whitehead has also obtained an analogous result for general spaces [Proc. Nat. Acad. Sci. U.S.A. 34, 207-211 (1948); these Rev. 10, 392]. These results show that $\pi_{n+1}(K_n)$ is a group extension of a known group $\pi_n(K_n)$ by $H_{n+1}(K_n)$. The author then states a theorem on how this group extension may be effectively determined, and thus shows that $\pi_{n+1}(K_n)$ may be effectively calculated in terms of the invariants of K_n listed above.

A method is given for associating with any simplicial map $f: S^{n+1} \rightarrow S^n$ an integer in case $n=2$ or an integer mod 2 in case $n > 2$ which is an invariant of the homotopy class of f . For $n=2$ this turns out to be equal to the Hopf invariant of f . [Reviewers' note: such an invariant has also been defined by N. E. Steenrod; see the preceding review.] The last theorem gives a necessary and sufficient condition that an element of $H_{n+1}(K_n)$ be a spherical homology class i.e., belong to the image subgroup of Φ^{n+1} . No proofs are given in this note.

R. H. Fox and W. S. Massey

Source: Mathematical Reviews, 1950 Vol. 11 No. 2

Pontryagin, L.S.

Pontryagin, L.S. Classification of the mappings of an $(n-1)$ -dimensional sphere into a polyhedron K . [The fundamental group and Betti groups of dimensions $2, \dots, n-1$ are trivial.] Izvestiya Akad. Nauk SSSR, Ser. Mat. 16, 7-44 (1956); [Russian].

This paper is an exposition, including complete proofs, of results previously announced by the author [Doklady Akad. Nauk SSSR (N.S.) 65, 797-800 (1949); these Rev., 11, 122].

R.H. Fox and W.S. Massey.

Source: Mathematical Review, Vol. 11, No. 9

PONTRYAGIN, L. S.

Pontryagin, L. S. Homotopy classification of the mappings
of an $(n+2)$ -dimensional sphere on an n -dimensional one.
Doklady Akad. Nauk SSSR (N.S.) 70, 957-959 (1950).
(Russian)

In dieser Note wird gezeigt, dass für $n \geq 3$ die $(n+2)$ -te
Homotopiegruppe $\pi_{n+2}(S^n)$ der n -Sphäre S^n die Ordnung
2 hat, d.h. dass es zwei Homotopieklassen von Abbildungen
der S^{n+2} in die S^n gibt. Damit wird ein vom Verfasser früher
[C. R. (Doklady) Acad. Sci. URSS (N.S.) 19, 361-363
(1938)] formuliertes irrtümliches Ergebnis richtiggestellt.
Auf Grund der Sätze von Freudenthal [Compositio Math.
5, 299-314 (1937)] genügt zum Beweis des Satzes der
Nachweis einer wesentlichen Abbildung von S^{n+2} auf S^n für
 $n > 3$. Dieser Nachweis wird in folgender Weise erbracht
(der Gedankengang ist ausführlich dargelegt, die Beweise
einzelner Schritte jedoch nur angedeutet). Es sei f eine

Source: Mathematical Notes,

Vol. 22 No. 6

analytische Abbildung von S^{n+3} in S^n . Es gibt einen Punkt ∂S^n , für welchen $f^{-1}(y)$ ein System von zueinander fremden geschlossenen orientierbaren Flächen ist, und derart dass die Abbildung f in der Umgebung von F betrachtet in naheliegender Weise eine Abbildung von F in $V^{n+1,n+1}$ (die Mannigfaltigkeit aller Systeme von $n+1$ linear unabhängigen Vektoren im $(n+3)$ -dimensionalen Raum), d.h. ein System von zueinander fremden einfach geschlossenen glatten Kurven, so erhält man hieraus eine Abbildung φ von W in $V^{n+1,n+1}$, somit in die eigentliche orthogonale Gruppe O_{n+3} in $n+3$ -Gruppe von O_{n+3} , also eine ganze Zahl mod. 2. Für $\varphi(W)$ gilt (alle Gleichungen zwischen ganzen Zahlen sind mod 2 zu verstehen): 1) ist W , als ganzzähliger Zyklus aufgefasst homolog 0 auf F , so ist $\varphi(W)$ gleich der Korrespondenzzahl $b(W)$ von W , somit wenn $c(W) = a(W) + b(W)$ gesetzt wird, $c(W) = 0, 2$. Für 3) Viele W_1, W_2 sei ein Sinne ganzzähliger Zyklen W , homolog zu $W + W_1$; dann gilt:

$$\varphi(W) = a(W) + c(W),$$

und $b(W_1) = b(W) + b(W_1) + I(W, W_1)$, wo I die Schnitzzahl homologe Wege W, W_1 ist $c(W) = c(W) + c(W_1) + I(W, W_1)$. Für W_1, \dots, W_r ist also $c(W) = c(W_1) + \dots + c(W_r)$. Für wird $r = \sum r_i$ ist $a(W) + \sum r_i a(W_i)$ gesetzt; diese Zahl (mod. 2) ist von der Basis unabhängig und erweist sich als eine Homotopieinvariante $T(f)$ der Abbildung f von S^{n+2} in S^n . Zum Beweis der Invarianz bei Deformation von f ist eine geeignete analytische Approximation der Deformation erforderlich. Für eine nullhomotope Abbildung f ist $T(f) = 0$. Für die bekannte Abbildung g von S^3 auf S^2 , für welche in der Freudenthalischen K-Theorie [loc. cit.] die Entscheidung der Wesentlichkeit offen blieb (Einhängung der Faserprojektion von S^3 auf S^2 , gefolgt von derselben Projektion und von nochmaliger Einhängung), findet man durch explizite Konstruktion $T(g) = 1$; g ist also wesentlich.

B. Eichmann (Urbana, Ill.).

Source: Mathematical Reviews.

Vol.

13 No.

PONTRYAGIN, L. S. (Pontrjagin)

"Local Method of Investigation of Reflections of S^{n+k} Sphere into Sⁿ Sphere,"
Usp. Mat. Nauk Vol. 6 No. 4 (44), pp 193-220, 1951.

U-1635, 16 Jan 52

1. PONTRYAGIN, L. S.
2. USSR (600)
4. Physics and Mathematics
7. Works on Topology and Other Fields of Mathematics, P. S. Uryson,
(2 Vols. Moscow-Leningrad, State Technical Press, 1951). Reviewed by
L. S. Pontryagin. Sov. Kniga, No. 1, 1953.
9. [REDACTED] Report U-3081, 16 Jan. 1953, Unclassified.

PONTRYAGIN, L. S.

USSR/Mathematics - Regulation

21 Aug 53

"The Zeroes of Certain Elementary Transcendental Functions," (Supplement) L. S. Pontryagin, Corr. Mem, Acad Sci USSR

DAN SSSR, Vol 91, No 6, pp 1279-1280

States that the results (namely, the conditions for the stability of function $H(iy)$) of the present supplement and of his earlier work (Iz AN SSSR, Ser Mat. 6, 115, 1942) are connected with certain problems in the theory of regulation. Notes that

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these results are completely applicable to functions of a somewhat more general kind than the so-called quasipolynomials $H(z) = h(z, e^t)$ (here $h(z, t) = \sum_{m,n} a_m z^m t^n$) discussed here. Presented 10 Jun 53.

PONTRYAGIN, L.S.
(Lev Semenovich)

L.S. Pontryagin, L.S. Nepreryvnye gruppy. [Continuous groups.] 2d ed. Gosudarstv. Izdat. Tekn.-Teor. Lit., Moscow, 1954. 515 pp. 19.40 rubles.

This new edition of Pontryagin's book [1st ed. GTTI, Moscow, 1938; English translation, Princeton, 1939; MR

1, 44] on topological groups differs from the first by the many changes and augmentations of which the principal ones are: Addition of a new chapter on the classification of compact Lie algebras; insertion of a separate chapter on topological rings and fields; replacement of the locally compact separable groups which were considered throughout in the first edition by locally bicompact groups (and which we will call locally compact, sticking to the current terminology); addition of many new examples which illustrate or elaborate particular points of the general theory.

In chapter I, which discusses the basic concepts of group theory, a discussion of direct products (weak and strong) along with a discussion of the rank concept for non-finitely generated abelian groups is included in view of later needs. Apart from examples to these new topics a number of examples have been added to show how

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(cont.)

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groups arise very naturally as transformation groups in geometry. The chapter concludes with a discussion of the ring and field concept and the connection between the latter and projective geometry (Desargues' and Pascal's theorems).

Chapter II is a modern standard treatment of the fundamental topological notions like complete regularity, compactness, theorem of Tychonoff, connectedness, dimension. Some attention is paid also to the notion of weight=least cardinal of the open bases of the space.

Chapter III which considers topological groups in general has been expanded by a paragraph on transformation groups. Among the theorems proved here we mention: a locally compact group acting effectively and transitively on a locally compact Hausdorff space has but one locally compact topology compatible with the way in which the group operates on the space.

Chapter IV is entirely new and is mainly devoted to the proof of a general structure theorem for locally compact nondiscrete fields due to Kowalsky and which says that any such field is a finite extension either of the reals, or of a p -adic field, or of the field of formal power series over the prime field of characteristic $p > 0$.

Chapter V develops integration on compact groups by von Neumann's method of means and proves the Peter-Weyl theorem. It is essentially a modernized version of

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Chapter IV in the old edition. In the new chapter V it gives an exposition of the theory of characters of locally compact abelian groups; questions of connectedness are considered in more detail than before (e.g., it is proved that dimension of compact abelian group = rank of character group; criteria for connectedness and local connectedness in terms of character group properties are given). Here also the weight concept finds some application.

The four following chapters are, except for some changes, the chapters VI-IX in the first edition. In chapter VIII some material on compact transformation groups is included (it is proved e.g. that any compact connected group acting effectively and transitively on a finite-dimensional locally connected space is a Lie group), and the chapter on covering spaces has been enriched by a number of examples.

Chapter eleven, the last one, gives an exposition of the structure theory of compact Lie algebras on the basis of the classical Killing-Cartan-Weyl theory. It concludes with an enumeration of the simple root systems after the method of Dynkin and gives their Coxeter diagrams explicitly.

The reviewer would have liked more references to work that has been done or is being done on subjects closely related to those treated in this book and which could not be reported on here. Despite this, however, the book seems to the reviewer to be still the best general introduction at present to the theory of topological groups. W.T. van Est.

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P.D. van Est

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* Pontryagin, L. S. Gladkie mnogoobraziya i ik prime-neniya v teorii gomotopii. [Smooth manifolds and their applications in homotopy theory] Trudy Mat. Inst. im. Steklov. no. 45. Izdat. Akad. Nauk SSSR, Moscow, 1955. 139 pp. 6.30 rubles.

MS 2-F/W

The present volume consists of a detailed account of the methods introduced by the author and developed by him and by V. A. Rohlin to study the homotopy classification problem for maps of S^{n+k} in S^n [see L. S. Pontryagin, C. R. (Dokl.) Acad. Sci. URSS (N.S.) 19, 147-149 (1938); 70, 957-959 (1950); MR 13, 57; V. A. Rohlin, ibid. (N.S.) 80, 541-544; 81, 19-22 (1951); 84, 221-224 (1952); MR 13, 674; 14, 573].

Chapter I consists of a study of smooth (differentiable) manifolds M^k . This study is taken considerably further than is required for the subsequent applications. Of particular value is a comparatively simple account of the Whitney theorem on the smooth embeddability of M^k in E^{2k+1} , Euclidean space of $(2k+1)$ dimensions, and a discussion of the properties of the singular points of a smooth map of M^k in E^r , $r < 2k+1$, particularly $r = 2k, 2k-1$.

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(over)

USSR/Mathematics

Card Pub. 22 - 9/54

Authors : Mishchenko, Ye. F., and Pontryagin, L. S., Member-Correspondent of
the Acad. of Sc., USSR

Title : Periodic solutions of systems of differential equations near the
points of discontinuity

Periodical : Dok. AN SSSR 102/5, 889-891, June 11, 1955

Abstract : A periodic solution is sought for a system of differential
equations of the following type: $\varepsilon \dot{x} = f(x, y)$, $\dot{y} = g(x, y)$ where the ε
is a small positive parameter. The solution is found near the points
of discontinuity and is given up to $O(\varepsilon)$ precision. A method of de-
termining the period T is presented. Two USSR references (1947-1951).

Institution : The Acad. of Sc., USSR, V. A. Steklov Institute of Mathematical Scs.

Submitted : April 1, 1955

SHTRYAN, L. S. (Corr. Mem.)

"Certain Mathematical Problems Arising in Connection with the Theory of Optimal Systems of Automatic Regulation,"

paper read at the Session of the Acad. Sci. USSR, on Scientific Problems of Automatic Production, 15-20 October 1956.

Avtomatika i telemekhanika, No. 2, p. 182-192, 1957.

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TRANSACTIONS OF THE THIRD ALL-UNION MATHEMATICAL CONGRESS

Ball. No. 14. 1956.

Transactions of the Third All-Union Mathematical Congress (Cont.)
Jun-Jul '56, Trudy '56, v. 1, Issut. Ispit., Izdatel'stvo AN SSSR, Moscow, 1956, 237 pp.
Section of Mathematical Problems in Physics 217-227

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On Equilibrium Stability of the Relay System of Ordinary
Differential Equation. 217-218

Boltyanskiy, V. G. (Moscow), Gamkrelidze, R. V. (Moscow),
Pontryagin, L. S. (Moscow). On the Theory of
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Card 75/80

PONTRYAGIN, L.S.; MISHCHENKO, Ye.F.

Pavel Sergeevich Aleksandrov; on the occasion of the 60th anniversary of his birth and the 40th anniversary of his scientific activities. Usp.mat.nauk 11 no.4:183-192 Jl-Ag '56. (MLRA 9:11)

(Aleksandrov, Pavel Sergeevich, 1896-)
(Bibliography--Mathematics)

PONTRYAGIN, L.S.

1-FW

Boltyanskii, V. G.; Gamkrelidze, R. V.; and Pontryagin,
L. S. On the theory of optimal processes. Dokl. Akad.
Nauk SSSR (N.S.) 110 (1956), 7-10. (Russian)

Let the state of a physical system be described at time t by a vector function $x(t)$ with components x^1, \dots, x^n , and let the components of $x(t)$ satisfy a system of differential equations of the form

$$\dot{x}^i = f^i(x^1, \dots, x^n; u^1, \dots, u^r) = f(x, u) \quad (i=1, \dots, n),$$

where $u = (u^1(t), \dots, u^r(t))$ is a control vector with a prescribed range. The problem considered is that of determining the control vector $u(t)$ in such a way as to minimize the time interval required to change the vector $x(t)$ from a given state x_0 to a required state x_1 [cf. R. Bellman, I. Glicksberg, and O. Gross, Quart. Appl. Math. 14 (1956), 11-18; MR 17, 1206]. In the present paper, necessary conditions for a minimum are derived under suitable smoothness assumptions, as are sufficient conditions for a local minimum. E. F. Beckenbach

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Death Oct. 1964 (1956)

PONTRYAGIN, L.S.

38-5-2/6

AUTHOR: PONTRYAGIN, L.S.

TITLE: Asymptotic Behavior of the Solutions of Systems of Differential Equations With a Small Parameter in the Derivatives of Highest Order (Asimptoticheskoye povedenie resheniy sistem differentsial'nykh uravneniy s malym parametrom pri vysshikh proizvodnykh).

PERIODICAL: Izvestiya Akad.Nauk, Ser.Mat., 1957, Vol.21, Nr 5, pp.605-626(USSR)

ABSTRACT: The author considers the system

$$(1) \quad \begin{cases} \varepsilon \dot{x} = f(x, y) \\ \dot{y} = g(x, y) \end{cases}$$

where x and y are k - and l -dimensional vectors and the degenerated system

$$(2) \quad \begin{cases} f(x, y) = 0 \\ \dot{y} = g(x, y) \end{cases}$$

The asymptotic expansion of the solution

$$(3) \quad x = x(t, \varepsilon), \quad y = y(t, \varepsilon)$$

of (1) is obtained which holds also for $t = 0$ and the magnitudes of order $\varepsilon^{2/3}$ and $\varepsilon \ln \varepsilon$ are taken into account, while the magnitudes of order ε are neglected. The deviation of the solution (3) from a certain k -dimensional plane is determined with the same exactness.

CARD 1/2

Asymptotic Behavior of the Solutions of Systems of Differential Equations With a Small Parameter in the Derivatives of Highest Order 38-5-2/6

The main results of the paper have been already announced.
(Doklady Akad.Nauk 102, 889-891, 1955).

SUBMITTED: May 9, 1957

AVAILABLE: Library of Congress

CARD 2/2

PONTRYAGIN, L.S. Prof., USSR Academy of Sciences

"Optimal Processes of Regulation,"
paper submitted for Eleventh Intl Congress of Mathematicians, Edinburgh, Scotland,
14-21 Aug 58.

16,3400

16,8000 (1132)

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S/044/61/000/012/020/054
0:11/0333

AUTHOR:

Pontryagin, L. S.

TITLE:

Systems of ordinary differential equations with small parameters on the highest derivatives

PERIODICAL:

Referativnyy zhurnal, Matematika, no. 12, 1961, 35,
abstract 12B155. (Tr. 3-go Vses. matem. s"yezda",
1956. T. 3. M., AN SSSR, 1958, 570-577)

TEXT:

The lecture is devoted to a survey of the results obtained by L. S. Pontryagin and his disciples on the domain of systems with small parameters and the relation of these results with earlier investigations. The author mentions that a rigorous investigation of many questions of radio engineering leads to the necessity of investigating the solution of the ordinary system of differential equations

$$\begin{aligned} \varepsilon \dot{x} &= f(x, y), \\ \dot{y} &= g(x, y) \end{aligned} \quad (1)$$

where $x = (x^1, \dots, x^k)$, $y = (y^1, \dots, y^l)$ are the unknown functions of the time, $\varepsilon > 0$ is a small parameter, where magnitudes which are small

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Systems of ordinary differential equations of one or another order in ϵ are neglected. In other words: The asymptotic series expansion

$$x = \varphi(t, \epsilon), \quad y = \psi(t, \epsilon) \quad (2)$$

of the solution of (1) and the calculation of some terms of this series are to be investigated. Concerning "the system of quick motions"

$$\epsilon \dot{x} = f(x, y) \quad (3)$$

(y is a constant parameter) the assumption is made that each solution of (3) tends for $t \rightarrow \infty$ to an exponentially stable stationary solution

$$x = \varphi(t, y, \epsilon) \quad (4)$$

i. e. either to a position of equilibrium or to a limit cycle. The solution (4) depends on the vector parameter y and maintains its exponential stability in a certain domain Γ of this parameter. Under the approximation of the point $\psi(t)$ to the boundary of Γ the stationary solution (4) does no longer exist, or in any case loses its exponential stability; a more complicated transition process occurs.

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C:11/333

Systems of ordinary differential

1. If the stationary solution (4) is a position of equilibrium, then the asymptotic series expansion of the solution of (2) in terms of integer powers of ϵ in the domain Γ was investigated by A.N. Tikhonov and his disciples. The transient process was investigated for the first time by the author and Ye. F. Mishchenko (R Zh Mat, 1956, 2983) for the case, where the position of equilibrium vanishes because of the "union" with another unstable position of equilibrium and where the stationary solution arising by the transient process is again a position of equilibrium. The asymptotic expansion of the solution on the "transition interval" was determined under consideration of the terms $\epsilon^{2/3}$ and $\epsilon \ln \epsilon$ and under neglect of the terms ϵ ; the periodic solution of (1) and its period are calculated with the same exactness. X

2. If the stationary solution (4) is periodic

$$x = \bar{\varphi} \left(\frac{t}{\epsilon T(y)} + y \right); y \in \Gamma,$$

with variable period $\epsilon T(y)$, then the author and L. V. Rodygin have proved that the "averaging method" can be applied which has been

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Systems of ordinary differential . . . C111/C333

formerly elaborated for the case of constant T (N. N. Bogoliubov and Yu. A. Mitropol'skiy, Asimptoticheskiye metody v teorii nelineynykh kolebaniy [Asymptotic methods in the theory of non-linear oscillations], Fizmatgiz, M., 1958; R Zh Mat, 1959, 3786K). Furthermore, there was constructed an approximate solution of the system (1) with exactness up to the terms \mathcal{E} . The periodic solution of the system (1) is investigated with the same exactness. The appearance of a "discontinuous" solution in the multivibrator is described.

Note of the reviewer: The author and Ye. F. Mishchenko published a detailed investigation of case 1 (R Zh Mat, 1958, 6709, 6712). In the case $k = l = 1$, Ye. F. Mishchenko continued the computation and found the term with order \mathcal{E} (R Zh Mat, 1961, 10B137). The investigation of case 2 was published by the author and L. V. Rodygin (R Zh Mat, 1961, 4B207 and Dokl. AN SSSR, 1960, 131, No. 2, 255-258).

[Abstracter's note: Complete translation.]

Card 4/4

AUTHOR: Mishchenko, Y. F. and Pontryagin, L. S., Corresponding Member of the Academy of Sciences of the USSR 20-120-5-10/67

TITLE: The Proof of Certain Asymptotic Formulas for the Solutions of Differential Equations With a Small Parameter (Dokazatel'stvo nekotorykh asimptoticheskikh formul dlya resheniy differentsial'nykh uravneniy s malym parametrom)

PERIODICAL: Doklady Akademii nauk SSSR, 1958, Vol 120, Nr 5, pp 967-969 (USSR)

ABSTRACT: In [Ref 2] Pontryagin calculated the formal asymptotic expansions of the solutions of the system

$$(1) \begin{aligned} \dot{x}^i &= f^i(x^1, \dots, x^k, y^1, \dots, y^l) \\ \dot{y}^j &= g^j(x^1, \dots, x^k, y^1, \dots, y^l) \end{aligned}$$

(i=1, ..., k) (j=1, ..., l)

in the neighborhood of a point for which $\det \left\| \frac{\partial f^i}{\partial x^a} \right\| = 0$. These expansions were essentially applied in [Ref 1] and in the joining paper of Mishchenko [Ref 2]. In the present paper it is proved that these formal expansions really approximate the solutions of (1) with the given exactness. The proof consists

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The Proof of Certain Asymptotic Formulas for the Solutions of Differential Equations With a Small Parameter 20-120-5-10/67

In the construction of a "tube", i.e. of a narrow closed neighborhood of the formal approximations. The diameter of the tube tends to zero with ξ^a , $a > 0$. It is proved that for initial values inside of the tube the solution also runs inside of the tube.

There are 3 Soviet references.

SUBMITTED: March 6, 1958

1. Differential equations

Card 2/2

16(1)

AUTHOR:

Pontryagin, L.S.

SOV/42-14-1-1/27

TITLE:

Optimal Control Process (Optimal'nyye protsessy regulirovaniya).
Uspekhi matematicheskikh nauk, 1959, Vol 14, Nr 1, pp 3-20 (USSR).

PERIODICAL:

This is a connected representation of results announced already
in earlier papers of the author and his pupils V.G.Boltyanskiy
and R.V.Gamkrelidze [Ref 1,2,3] (compare also the report of
Pontryagin at the Mathematical Congress in Edinburgh in 1958).
There are 7 references, 4 of which are Soviet, and 3 American.

ABSTRACT:

SUBMITTED: October 8, 1958

Card 1/1

16.3400

2

~~16(1)~~
AUTHORS:

Mishchenko, Ye.F., Pontryagin, L.S.

05698

TITLE:

The Proof of Some Asymptotic Estimations for the Solutions of Differential Equations With Small Parameter in the Derivatives

SOV/38-23-5-2/8

PERIODICAL:

Izvestiya Akademii nauk SSSR, Seriya matematicheskaya, 1959,
Vol 23, Nr 5, pp 643 - 660 (USSR)

ABSTRACT:

In [Ref 1] there were obtained formal asymptotic expansions for the solutions of

$$(1) \quad \begin{aligned} \dot{\epsilon}^i &= f^i(x^1, \dots, x^k, y^1, \dots, y^l) \\ \dot{y}^j &= g^j(x^1, \dots, x^k, y^1, \dots, y^l) \end{aligned} \quad (i = 1, \dots, k; j = 1, \dots, l)$$

in the neighborhood of the points in which $\det \left\| \frac{\partial f^i}{\partial x^j} \right\| = 0$

In the present paper the authors prove that these formally calculated expansions really approximate the solutions of (1) with given exactness. By linear transformation and choice of a new independent variable (1) is brought to the form

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16(1)- 16.1510

66154

AUTHORS: Mishchenko, Ye.F., Pontryagin, L.S., Academician SOV/20-128-5-6/67

TITLE: One Statistical Problem on Optimum Control

PERIODICAL: Doklady Akademii nauk SSSR, 1959, Vol 128, Nr 5, pp 890-892(USSR)

ABSTRACT: The point z is called controlled, if its motion is described by

(1) $\dot{z}^i = f^i(z^1, \dots, z^n, u), i=1, \dots, n$, where u is a control parameter. The point Q is called random, if the distribution of the probabilities of its possible positions satisfies the first differential equation of A.N.Kolmogorov
[Ref 1]:

$$(2) \frac{\partial p}{\partial \sigma} + a^{ij}(x, \sigma) \cdot \frac{\partial^2 p}{\partial x^i \partial x^j} + b^i(x, \sigma) \frac{\partial p}{\partial x^i} = 0.$$

If the initial positions of z and Q are known, then the probability that z meets the neighborhood \sum_z of z within a certain time interval $t_0 < t < t_1$ is a functional of the control $u(t)$. The control $u(t)$ is denoted as optimum, if this functional attains an extreme value. The problem of optimum control can be solved, if the functional is known. In the

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One Statistical Problem on Optimum Control

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present paper the authors show that, if \sum_z is a sphere with the radius ϵ , the main term of the functional has the form

$$(4) \quad \epsilon^{n-2} \Psi_u(x, \sigma, \tau),$$

where x is the position of Q in the moment σ . The authors give the outlines of a scheme for the calculation of the main term without proof.

There are 3 references, 1 of which is Soviet, 1 American, and 1 French.

ASSOCIATION: Matematicheskiy institut imeni V.A. Steklova AN SSSR
(Mathematical Institute imeni V.A. Steklov AS USSR)

SUBMITTED: July 15, 1959

Card 2/2

CONFIDENTIAL

Report to be presented at the 1st Int'l Congress of the Int'l Federation of Automatic Control, 25 Jun-5 Jul 1960, Moscow, USSR.

ABREKOV, D. A. - "Compensating thermostatic gas analyzers"

AZBUDIN, N. I. - "Method of determining the optimum dynamic system according to the criterion of the functional, which is a sum function of several other functions"

AFANAS'EV, M. A., and GOL'DMACHEV, P. P. - "Some Problems of the theory of nonlinear systems of automatic regulation with discontinuous characteristics"

ALFANOV, R. A. - "Concerning the organization of the LAPLACE function for nonlinear systems"

BAGAEV, A. V. - "Graphical methods of synthesis of nonlinear systems of automatic regulation"

BASHEV, S. M. - "Problems of the application of high liquid pressures for automatic systems"

BENCI, BALINT, A. - "The theory of stability of regulation systems"

BENCI, GIL, B. - "Polar-coordinate nonlinear regulator for processes connected with machines"

BENCI, GIL, and SALI, A. A. - "Parametrically stable systems"

BENCI, GIL, and TUTTLETT, V. I. - "Contactless systems"

BOLOTOV, O. A. - "Automated electric drive of the propeller, installation of the atomic brake, and application of the equivalent transmission function in the calculation of follower systems by the logarithmic frequency method"

BULIN, B. V., KERZHNIKOV, J. A., and PRANDTEIN, I. V. - "Contactless telemechanical systems with temporary separation of channels"

BULYANTSEV, V. G., GANOVICH, P. V., KISSELEV, N. P., and SHURSHAKOV, I. G. - "The maximum principle in the theory of optimal control processes"

BUROV, M. M. - "Automated electric drives of a serial-mechanical plant"

SURDOV, I. A. - "Automatic regulation of front-layer processes in noncircular metalworking"

16(1)

AUTHORS: Boltyanskiy, V.G., Gamkrelidze, R.V.,
and Pontryagin, L.S. S/038/60/024/01/001/006

TITLE: Theory of Optimal Processes. I Maximum Principle

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya matematicheskaya, 1960,
Vol 24, Nr 1, pp 3-42 (USSR)

ABSTRACT: The paper contains a detailed representation of the results
published by the authors in [Ref 1-6, 10]. At the
Mathematical Congress in Edinburgh L.S.Pontryagin has
reported about the most essential results.
There are 10 references, 7 of which are Soviet, 1 German,
and 2 American. 

SUBMITTED: May 14, 1959

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16(1) 16.3400

68972

S/020/60/131/02/010/071

AUTHORS: Pontryagin, L.S., Academician,
and Rodygin, L.V.

TITLE: Approximate Solution of a System of Ordinary Differential
Equations Involving a Small Parameter With the Derivatives

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol 131, Nr 2, pp 255-258 (USSR)

ABSTRACT: The authors consider the behavior of the solutions of the
system of differential equations

$$(1) \quad \frac{dx}{dt} = f(x,y), \quad \frac{dy}{dt} = g(x,y),$$

where $x=(x_1, \dots, x_k)$, $y=(y_1, \dots, y_l)$ on a finite interval. The
proofs of the results announced at the Third Mathematical All-
Union Congress 1956 are given (compare [Ref 17]).

SUBMITTED: December 11, 1959

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16.3400

S/020/60/132/03/14/066

AUTHORS: Pontryagin, L.S., Member of the Academy, and Rodygin, L.V.TITLE: Periodic Solution of a System of Ordinary Differential Equations With
a Small Parameter Attached to the Derivatives

PERIODICAL: Doklady Akademii nauk SSSR, 1960, Vol. 132, No. 3, pp. 537-540

TEXT: The authors consider the system

(1) $\epsilon \frac{dx}{dt} = f(x, y), \quad \frac{dy}{dt} = g(x, y)$

where $x = (x_1, \dots, x_k)$, $y = (y_1, \dots, y_l)$, $\epsilon > 0$, the vector functions f and g are three times continuously differentiable. It is assumed that the multipliers $\lambda_1, \dots, \lambda_{k-1}$ of the system in variations

(3) $\dot{\xi} = f_y(x, y)|_{x=x^*} \xi$

where $f_y(x, y) = \left\| \frac{\partial f_i(x, y)}{\partial y_j} \right\|$ and $x^* = x^*(\tau, y)$ is the single non-

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S1226

Periodic Solution of a System of Ordinary Differential Equations With a Small Parameter Attached to the Derivatives

S/020/60/132/03/14/066

Degenerated periodic solution (period $T(y)$) of

$$(2) \quad \frac{dx}{dt} = f(x, y),$$

$y = \text{const}$ - parameter, are different from 1 except of one multiplier. The authors introduce the "averaged system"

$$(4) \quad \frac{dy}{dt} = \bar{g}(y) = \frac{1}{T(y)} \int_0^{T(y)} g(x^*(\tau, y), y) d\tau = \int_0^1 g[x(\varphi, y), y] d\varphi$$

where $X(\varphi, y) = x^*(T(y)\varphi, y)$ and they assume that (4) has a non-degenerated position of equilibrium y_0 .

Theorem : Under the given assumptions, for sufficiently small ϵ in the neighborhood of the cycle $\{x^*(\tau, y_0), y_0\}$, (1) has a unique periodic solution $\{x(t, \epsilon), y(t, \epsilon)\}$ with the properties : Its period is $\epsilon T(y_0) + O(\epsilon^2)$ and it holds $|y(t, \epsilon) - y_0| = O(\epsilon)$. Here there exists a function $\psi(t, \epsilon)$ ("phase") , smoothly depending on t, with the property that

Card 2/3

X

PONTRYAGIN, Lev Semenovich; BOLTYANSKII, V.G., red.; BAYEVA, A.P., red.;
YERMAKOVA, Ye.A., tekhn. red.

[Ordinary differential equations] Obyknovennye differentsial'nye
uravneniya. Moskva, Gos. izd-vo fiziko-matem. lit-ry, 1961. 311 p.
(Differential equations) (MIRA 14:7)

BR

PHASE I BOOK EXPLOITATION

SOV/5883

Pontryagin, Lev Semenovich, Vladimir Grigor'yevich Boltyanskiy, Revaz Valerianovich Gamkrelidze, and Yevgeniy Frolovich Mishchenko

Matematicheskaya teoriya optimal'nykh protsessov (Mathematical Theory of Optimum Processes) Moscow, Fizmatgiz, 1961. 391 p. 10,000 copies printed.

Ed.: N. Kh. Rozov; Tech. Ed.: K. F. Brudno.

PURPOSE: This book is intended for specialists concerned with the mathematical theory of optimum control processes.

COVERAGE: The book contains a systematic presentation of results on the theory of optimum control processes obtained by the authors during the years 1956-1961. Some data obtained from other scientists are also included. The authors' so-called "Principle of Maximum" makes possible the solution of a considerable number of variational problems of nonclassical type associated with the optimization of controlled processes. The principle is presented in detail and is compared with Bellman's principle of dynamic programming. A series of problems on optimum processes is studied on the basis of general methods of the Principle

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of characters. No personalities are mentioned. There are 28 references: 23 Soviet, 4 English, and 1 German.

TABLE OF CONTENTS:

Introduction

Ch. I. Principle of Maximum

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Card 2/6

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S/569/61/002/000/002/008
D298/D302

16.8000 (1031, 1132, 1329)

AUTHORS: Boltynskiy, V.G., Gamkrelidze, R.V., Mishchenko, Ye.
F., and Pontryagin, L.S. (USSR)

TITLE: Principle of maximum in the theory of optimal
processes

SOURCE: IFAC, 1st Congress, Moscow 1960. Teoriya diskretnykh,
optimal'nykh i samonastraivayushikhsya sistem.
Trudy, v. 2, 1961, 457 - 470

TEXT: The general optimum problem is formulated, as well as the
basic equations obtained by the authors. The n-dimensional phase-
space X^n is considered, and the controlled object (plant) is de-
scribed by the vector equation

$$\dot{x} = f(x, u), \quad f = (f^1, \dots, f^n); \quad (2)$$

is the class of allowed controllers is defined as the class of pie-
cwise linear functions $u(t)$, $t_1 \leq t \leq t_2$. The optimum problem is
formulated as follows: The two points ξ_1, ξ_2 are given in X^n ; it

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Principle of maximum in the theory ...

is required to choose, among the allowed controllers, a controller $u(t)$, so that the corresponding trajectory $x(t)$ of Eq. (2), defined on the entire interval $t_1 \leq t \leq t_2$, connects the points ξ_1, ξ_2 , ($x(t_1) = \xi_1, x(t_2) = \xi_2$), and the integral

$$\int_{t_1}^{t_2} f^0(x(t), u(t)) dt \quad (3) \quad \checkmark$$

is minimized. Any allowed controller which satisfies the above conditions, is called the optimal controller, and the corresponding trajectory -- optimal trajectory. Depending on the choice of the function $f^0(x, u)$ integral (3) may represent the time elapsed, the fuel, energy, etc. spent during the process. The necessary conditions which any optimal controller and its corresponding trajectory satisfies, are expressed by the following basic theorem 1, called the principle of maximum. Preliminarily, the vector \bar{x} of $(n+1)$ -dimensional space X^{n+1} is introduced, as well as the covariant vector ψ and the scalar function

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$$H(\bar{\psi}, x, u) = \sum_{\alpha=0}^n \psi_\alpha f^\alpha(x, u).$$

Thereupon the Hamiltonian system of equations

$$\dot{x}^i = \frac{\partial H(\bar{\psi}, x, u)}{\partial \psi_i}, \quad i = 0, \dots, n \quad (6)$$

$$\dot{\psi}_i = \frac{\partial H(\bar{\psi}, x, u)}{\partial x^i}, \quad i = 0, \dots, n \quad (7)$$

is set up. The notation

$$M(\bar{\psi}, x) = \sup_{u \in \Omega} H(\bar{\psi}, x, u)$$

is used. Theorem 1 (principle of maximum): Let $u(t)$ be the optimum controller and $x(t)$ -- the corresponding optimum trajectory of (2). Then the nonzero, covariant, continuous function $\psi(t)$ can be found

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Principle of maximum in the theory ...

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so that the coordinates x^1 and x^0 satisfy on the interval $t_1 \leq t \leq t_2$ the Hamiltonian system

$$\dot{x}_i = \frac{\partial H(\Phi, x, u)}{\partial \varphi_i} \quad | \quad i = 0, 1, \dots, n$$

principle of maximum holds also under more general assumptions than above. Under certain conditions, the problem is equivalent to Lagrange's problem of variational calculus, whereby the principle of maximum coincides with Weierstrass's criterion. The basic difference between both formulations consists in the arbitrariness of the set Ω (of the values of u) in the case of the principle of maximum. The optimum problem for the case of limited phase coordinates means

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Principle of maximum in the theory ...

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that only such allowed controllers can be chosen, for which the corresponding phase trajectory of (2) belongs entirely to a fixed, closed region G of n -dimensional phase space X^n . In this case the functional (3) is minimized. Further, a theorem is formulated for optimal trajectories which lie at the boundaries of the region G . In order to uniquely determine the optimum trajectory, a further condition has to be satisfied by the trajectory when it passes from the interior of G to its boundary; this condition is called discontinuity (jump) condition (as the covariant function Ψ may undergo a discontinuity). Points of the boundary $g(x) = 0$, which satisfy certain conditions, are called point of contiguity (junction). A theorem is formulated which relates the discontinuity conditions to the points of contiguity. Further, a statistical problem is stated. The significance, for optimization theory, of the obtained result, has yet to be ascertained. It is noted, that it led already to the solution of a new problem "small parameter" for parabolic equations. The phase-coordinates are denoted by z . In addition, the point Q with probability distribution in the space R , is considered. It is required to select the controller $u(t)$ of z so that the functional

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16,8000 (132,1344)

26760
S/038/61/025/004/001/003
C111/C444

AUTHORS: Mishchenko, Ye. F., Pontryagin, L. S.

TITLE: On a statistical problem of optimal control

CONFIDENTIAL Akademicheskay. Izdatelstva. Seriya matematicheskaya.

where $u = (u^1, \dots, u^r)$ is the controlling parameter.

The motion of the point $Q \in R$ be a Markov process. The probability density of the fact that the point Q , being in the position x at the moment σ , takes the position y at the moment τ , be $p(\sigma, x, \tau, y)$. As a function of σ and x , $p(\sigma, x, \tau, y)$ forms the fundamental solution of the A. N. Kolmogorov equation

$$\frac{\partial p}{\partial \sigma} + a^{ij}(\sigma, x) \frac{\partial^2 p}{\partial x^i \partial x^j} + b^i(\sigma, x) \frac{\partial p}{\partial x^i} = 0 \quad (2)$$

One supposes that: the right hands of (1) are continuous in all va-

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On a statistical problem...

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riables and continuously differentiable with respect to z^1, \dots, z^n ; the $a^{ij}(\sigma, x)$, $b^i(\sigma, x)$, $i, j = 1, \dots, n$ are defined and continuous for $\sigma > 0$ and arbitrary $x \in R^n$; all eigenvalues of the matrix $\|a^{ij}(\sigma, x)\|$ have a positive upper and lower bound for these values of the arguments; $b^i(\sigma, x)$ do not increase with $|x|$ faster than $e^{|x|}$.

Let a certain small neighborhood \sum_z of z (e. g. a sphere with radius ϵ) move with z . Let $h(t)$ be a non-negative function $h(t) \leq 1$, defined on the whole t -axis. Let $\Psi_u(\sigma, x, \tau)$ be the probability for the fact that the point Q , having been in the position x at the moment σ , meets the neighborhood \sum_z of z in the time interval $\sigma \leq t \leq \tau$ (an initial position $z(\sigma)$ be given).

Problem: Determine $u(t)$ such that the functional

$$I = \int_0^\infty h(s) \frac{\partial}{\partial s} \int_0^s [V_u(t, s, u)] ds dt$$

is minimum.

On a statistical problem...

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attains a maximum. The control $u(t)$ thus defined and the corresponding $z(t)$ are called optimal. Thus the problem leads to the maximum principle which often has been considered by Pontryagin and others, if (7) is known as a functional of $u(t)$ and $z(t)$. This last problem is considered in this paper. The following final result is obtained:

Let $\lambda_1, \dots, \lambda_n$ be the eigenvalues of $\| a^{ij} \|$; let a_{ij}^{-1} be the inverse matrix to $\| a^{ij} \|$; let $G(\sigma, x, \tau, \eta) =$

$$= \frac{1}{[2\pi(\tau - \sigma)]^{\frac{n}{2}}} \exp \left\{ - \frac{a_{ij}(\eta^i - x^i + z^i(G)) (\eta^j - x^j + z^j(G))}{4(\tau - \sigma)} \right\};$$

Let $|x - z(G)| > r_0$, where r_0 is an arbitrary positive number independent from ε ;

Then $\Psi(\sigma, x, \tau) = \varepsilon^{n-2} [\Psi_0(\sigma, x, \tau) + \Psi_1(\sigma, x, \tau) + o(\varepsilon^{n-2})]$,

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On a statistical problem

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$$-\int G(\zeta, x, \tau, \eta) \frac{\alpha \sqrt{\lambda_1 \dots \lambda_n}}{[a_{ij} \eta^i \eta^j]^{\frac{n-2}{2}}} d\eta,$$

$$\Psi_1(G, x, \tau) = \int_{\sigma'}^{\tau} ds \int p(\zeta, x, \zeta, y) [b^i - z^{i'}(s)] \frac{\partial \Psi_0(s, y, \tau)}{\partial y^i} dy$$

and α being a constant, not depending on the equations of motion of z and Q and being uniquely defined by the size of the ellipsoid S :

$$\lambda_1 \bar{\eta}^{12} + \dots + \lambda_n \bar{\eta}^{n2} = 1.$$

There are 3 Soviet-bloc references and 1 non-Soviet-bloc reference.
SUBMITTED: October 29, 1960

Card 4/4

PONTRYAGIN, L. S.

"A statistical problem in the theory of optimal control"

report submitted at the Intl Conf of Mathematics, Stockholm, Sweden,
15-22 Aug 62

KOLMOGOROV, A.N., akademik; MISHCHENKO, Ye.F.; PONTRYAGIN, L.S., akademik

Probability problem of optimum control. Dokl.AN SSSR 145
no.5:993-995 '62. (MIRA 15:8)

1. Matematicheskiy institut im. V.A.Steklova AN SSSR.
(Probabilities) (Automatic control)

"APPROVED FOR RELEASE: 07/13/2001

CIA-RDP86-00513R001342210004-4

APPROVED FOR RELEASE: 07/13/2001 CIA-RDP86-00513R001342210004-4"

L 164.1-65 EWT(d)/EWP(1)/T Pg-4 IJP(c)/ESD(dp)/ASD(a)-5/AFMD/C/AFETR
ACCESSION NR: AP4041135 S/0020/64/156/004/073B/0741

AUTHOR: Pontryagin, L. S. (Academician)

TITLE: Certain differential games *B*

SOURCE: AN SSSR. Doklady*, v. 156, no. 4, 1964, 738-741

TOPIC TAGS: differential game, pursuit game, automatic control theory

ABSTRACT: The author assumes that the state of an object of control is defined by a point $z = (z^1, \dots, z^n)$ in an n-dimensional vector space R , and that its behavior is determined by a system of ordinary differential equations

whose right sides are analytic functions, where u and v are control parameters. Here u is a point in an analytic p-dimensional manifold P , and v is a point in an analytic q-dimensional manifold Q . An analytic manifold M of arbitrary dimension is given in the space R , and the game ends when the point z reaches the

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ACCESSION NR: AP4041135

manifold M. The problem consists in determining a behavior for the parameter u that will lead to termination of the game in the shortest possible time, and determination of the z and the value of P in this time. We should note that at certain points z it is necessary to use not only the values of the parameter v, but a certain number of its time derivatives. The parameter v is assumed to be a piece-wise analytic function of time. The author states conditions under which the problem is solvable, finds the relationship between his solution and Bellman's solution, and presents an example. Orig. art. has: 21 equations

ASSOCIATION: None

SUBMITTED: 17Mar64

ENCL: 00

SUB CODE: MA

NO REF SOV: 001

OTHER: 000

Card 2/2

L 15765-65 EMT(d) TPD(c)/ESD(ep)/SSD/AFWL/ASD(a)-5/AFTG(b)
ACCESSION NR: AP4041391 S/0020/64/156/006/1277/1280

AUTHPRS: Krivenkov, Yu.P.; Pontryagin, L.S.; Academician

TITLE: Sufficiency of the principle of the maximum¹³ in linear dynamic
programming problems

SOURCE: AN SSSR. Doklady*, v. 156, no. 6, 1964, 1277-1280

TOPIC TAGS: bottleneck problem, linear problem, dynamic program-
ming, linear program-
ming

ABSTRACT: Previous discussions of the bottleneck problem, which re-
duces to problems for which L.S. Pontryagin's principle of the maxi-
mum is valid, have not provided sufficient conditions for optimality
for the case of a variable control region and a phase space with a
stationary boundary. The author eliminates this disadvantage by
considering the system

$$\frac{dx}{dt} = f(x, u), \quad (1)$$

in which $f(x, u) = Ax + Bu + A_0$, $x(t) = (x_1, x_2, \dots, x_n)$ is a vector
of phase coordinates, $u(t) = (u_1, \dots, u_r)$ is a control vector, and

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ACCESSION NR: AP4041391

A , B , and A_0 are matrices and vectors of appropriate orders. The class of admissible controls U is the class of piecewise-continuous vector functions $u(t)$ defined on the segment $T_0 \leq t \leq T$ with values in a r -dimensional closed convex polygon $U(x)$ by the inequalities

$$S(v, u) \leq 0, \quad (2)$$

function $\psi(t)$, $t \in [T_0, T]$, that satisfies the conditions

$$(\psi(T_0), e_i^1) = 0 \quad \text{for all } i = 1, 2, \dots, k_{11}; \quad (14)$$

$$(\psi(T), e_i^2) = 0 \quad \text{for all } i = 1, 2, \dots, k_{21}.$$

$$\psi_0(T_0) = -1. \quad (15)$$

$$\frac{d\psi_0}{dt} = 0; \quad \frac{d\psi_i}{dt} = -\frac{\partial H}{\partial x_i} + \sum_{a=1}^{n_i} s_{ia} \frac{\partial S'_{ia}}{\partial x_i} = -\frac{\partial H}{\partial x_i} - \omega_i(t) \quad (i = 1, 2, \dots, n) \quad (13)$$

$$\omega_i(t) = \sum_{a=1}^{n_i} s_{ia} - \bar{S}'_{ia}, \quad \text{where} \quad S'_{ia} = \left(-\frac{\partial s_{ia}}{\partial x_1}, -\frac{\partial s_{ia}}{\partial x_2}, \dots, -\frac{\partial s_{ia}}{\partial x_n} \right). \quad (11)$$

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ACCESSION NR: AP4041391

in which the coefficients s_{α} ($\alpha = 1, 2, \dots, p_1$) are defined for all $t \in [T_0, T_1]$ by the expression

$$\psi(t) = \sum_{\alpha=1}^{p_1} s_{\alpha} S_{\alpha} + \sum_{\beta=1}^q o_{\beta} O_{\beta}, \quad (9)$$

composed for the value of $u_m(t)$ corresponding to a maximum of the functional $\sum_{i=1}^m \psi_i = \text{const} + (\varphi, u)$ at each point $t \in [T_0, T_1]$, then the control $u = u_m(t)$ is optimal on $[T_0, T_1]$. Orig. art. has: 17 equations.

ASSOCIATION: Moskovskiy fiziko-Tekhnicheskiy institut (Moscow
Physicotechnical Institute)

SUBMITTED: 20Jan64

ENCL: 00

SUB CODE: DP

NR REF Sov: 003 OTHER: 003

PONTRYAGIN, Lev Semenovich; BOLTYANSKIY, V.G., red.; RYBKI^N, G.F.,
red.

[Ordinary differential equations] Obyknovennye differentsial'-
nye uravneniya. Izd.2., perer. Moskva, Nauka, 1965. 331 p.
(MIRA 18:6)

L 46942-65 EWT(d)/T/EWP(1) IJP(c)

ACC NR: AP6028012

SOURCE CODE: UR/0042/66/021/004/0219/0272

8
B

AUTHOR: Pontryagin, L. S.

ORG: none

estimate

ABSTRACT: The pursuit of one controlled object by another controlled object in the case when the future behavior of the pursued object is not known to the pursuer is considered as the initial problem. To simplify the deductions, the pursuit problem is generalized and converted to a problem of the theory of differential games corresponding to the differential equation in vector form.

$$\dot{z} = Z(z, u, v) = X(z, u) + Y(z, v), \quad (1)$$

where $z = (z^1, z^2, \dots, z^n)$ is the vector of the n-dimensional Euclidean space, u and v are control vectors (parameters), and X and Y are differentiable functions. To study the differential game (1), constructions similar to those used in deriving the

TG

Card 1/2

UDC: 519.9

Card 2/2

ACC NR: AP6032273

SOURCE CODE: UR/0020/66/170/002/0290/0293

AUTHOR: Plotnikov, V. I.; Pontryagin, L. S. (Academician)

ORG: Gor'kiy State University im. N. I. Lobachevskiy (Gor'kovskiy gosuniversitet)

TITLE: On a problem of the optimal control of steady-state systems with distributed parameters

SOURCE: AN SSSR. Doklady, v. 170, no. 2, 1966, 290-293

TOPIC TAGS: optimal control, linear differential equation, existence theorem, uniqueness theorem

ABSTRACT: The authors present several new existence, sufficiency, and uniqueness theorems of optimal programming that lie in a certain theory of differential equations of the second order, for the distributed parameter systems, with distributed parameters. The authors give the method of proof, which consists of the following: first, they prove the so-called "fundamental inequality" (theorem 1), i.e., the inequality

$$\int_0^t \int_{\Omega} \left(u(t,x) - u_0(x) \right)^2 dx dt \leq C \int_0^t \int_{\Omega} \left| \nabla u(t,x) \right|^2 dx dt$$

where $0 \leq t \leq T$; then, they prove the uniqueness theorem.

Card 1/2

ACC NR: AP6032273

is proposed: If $g(p, \vec{\mu}) = \sum_{j=1}^n g_j(p)\mu_j$, where $g_j(p), p \in \Sigma$ are bounded measurable functions (Σ is the piecewise-smooth boundary of the n-variate bounded region), if M is the control region -- a convex set of permissible controls forming the functional class D -- and if there exists at least one control $\vec{\mu}(t) \in D$, for which $I_1(\mu) < +\infty$ (or $I_2(\mu) < D$), then there also exists an optimal control realizing $\inf_{\substack{\mu \in M \\ \mu \in D}} I_1(\mu)$ (or $\inf_{\substack{\mu \in M \\ \mu \in D}} I_2(\mu)$). Further, the necessary optimality criterion is formulated: if $\mu_0(t)$ optimal, then

$$\inf_{\mu \in M} \sum_{j=1}^n \Phi_j(\tau) \mu_j = \sum_{j=1}^n \Phi_j(\tau) \mu_{0j}(\tau) \quad (1)$$

and on this basis, switching and uniqueness theorems characterizing the properties of the optimal control $\mu_0(t) \in D$ are proved. Orig. art. has: 6 formulas.

SUB CODE: 12, 09, 09 / SUBM DATE: 24Dec65 / ORIG REF: 005

Cord 2/2

1. II. gynækologicke a porodnické kliniky, lekárskia fakulta Univerzity Komenskeho, Bratislava (for Bruchac).

*

PONTUCH, Anton (Bratislava, Zachova 5)

Obstetric aspect of lactation. Lek. obzor 3 no.3-4:166-173 1954.

1. Zo Zenskej a porodnickej kliniky SU v Bratislave.
(LACTATION, physiology.)

PONT'UCH, A.
PONT'UCH, A.

Significance of hemolytic diseases of newborn for prenatal care,
Bratisl.lek. listy 35 no.2:65-73 31 Jan 55.

1. Zo zenskej a porodnickej klin. LFKU v Bratislave; predn. prof.
dr. Sv.Stefanik.

(PREGNATAL CARE

role in fetal erythroblastosis)

(ERYTHROBLASTOSIS, FETAL

role of prenatal care)

PONT'UCH, Anton, MUDr.

Hemangioma (telangiectasis) of the uterine cervix. Cesk. gyn. 21
no.5:420-421 Nov 56.

l. I. zen. a por. klin. Bratislava, prednosta prof. Dr. Sv. Stefanik.
(TELANGIECTASIS
uterine cervix (Cz))
(CERVIX, UTERINE, blood supply
telangiectasis (Cz))

PONTUCH, Anton, MUDr.; BARDOS, Augustin, MUDr.

Technic of conducting premature delivery with reference to preventing trauma of the central nervous system; Gauss packs. Cesk. gyn. 22[36] no.5:376-385 June 57.

l. zen. pro. klinika v Bratislave, prednosta prof. MUDr. Svetozar Stefanik.

(BIRTH INJURY, prev. & control

Gauss packs in prev. of CNS inj. during premature delivery, technic (Cz))

(CENTRAL NERVOUS SYSTEM, wds. & inj.

prev. during premature delivery with Gauss packs, technic (Cz))

PONT'UCH, A. (Bratislava, Zochova 5.)

Clinical significance of prolonged pregnancy. Cas. gyn. 23[37] no.4:
311-315 June 58.

1. I. zen. por. klin. v Bratislave, prednosta prof. Dr. Sv. Stefanik.
(PREGNANCY,
prolonged (Cz))

PONT'UCH, A.; ZAJACOVA, E.

Selective management of delivery of placenta. Česk. vyn. 23[37] no.6:
438-442 Aug 58.

I. I. zen. por. klin. LFUK v Bratislave, prednosta prof. Dr. Sv. Stefanik.
A. P., I. zen. por. klin. LFUK, Bratislava.

(LABOR

3d stage, selective management of delivery of placenta (Cz))
(PIACENTA

delivery, selective management (Cz))

EXCERPTA MEDICA Sec 2 Vol 13/5 Physiology May 60

2578. AN EXPERIMENTAL AND CLINICAL STUDY OF THE ANTI-EMETIC ACTION OF CHLORPROMAZINE - Experimentalne a klinické sledovanie anti-emetického účinku chlorpromazínu (Largactilu) - Pontuch, A., and Toldy, M. Ľ. Zámek a Pôrodn. Klin., Bratislava - BRATISLAVSKÉ LÉK. LISTY 1960, 30(11)/1 (12-20) Graphs 3 Tables 1

The effective emetic dose of apomorphine was found in 6 female dogs to be 11.73 µg/kg. After administration of 19.8 mg. of chlorpromazine the effective dose of apomorphine rose to 64.01 µg/kg. ($P < 0.001$), and after 26 mg. of chlorpromazine to 177.8 µg/kg. ($P < 0.01$).

PREDNA, A.; SPISIAK, J.; PONTUCH, A.

The value of the buccal test in determination of sex chromatin.
Cesk.gyn.26[40] no.1/2:117-120 F '61.

l. sen.por.klin.lek.fak. UK v Bratislave, prednošta prof. MUDr.
S. Stefanik.
(CHROMOSOMES)

PONTUCH, A.; SKLOVSKA, M.

~~[REDACTED]~~ Coincidence of carcinoma portionis and ectopic gravidity. Neoplasma,
Bratisl.8 no.1:88-93 '61.

1. First Gynecological and Obstetrical Clinic of the Medical
Department of the Comenius University, Bratislava, Czechoslovakia.
(PREGNANCY ECTOPIC compl)
(CERVIX NEOPLASMS in pregn)

PONTUCH, Anton, -doc.

The secretion type of glandular hyperplasia of the endometrium.
Cesk. gym. 26[40] no.6:449-452 JT:61.

1. I zen. par. klin. LFUK v Bratislave, prednosta dr. S.Stefanik.
(ENDOMETRIUM diseases)

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The problem of the stump after supravaginal amputation of
the uterus. Cesk. gyn. 28 no.5:337-342 Je '63.

l. I gyn.-por. klin. Lek. fak. UK v Bratislave, prednosta
prof. dr. S. Stefanik.

(HYSTERECTOMY) (CERVIX NEOPLASMS)
(CARCINOMA, EPIDERMOID) (COLPOSCOPY)
(CYTODIAGNOSIS)

PONTUCH, A.

Obstetrical problems related to the immunization of pregnant women. Cesk. gynek. 28 no.7:462-465 S '63.

1. I zen.-por. klin. Lek. fak. UK v Bratislave, prednosta prof. dr. S. Stefanik.
(ERYTHROBLASTOSIS, FETAL) (EXCHANGE TRANSFUSION)
(FETAL DEATH) (INFANT MORTALITY)

PONTUCH, A.

Intrauterine fetal death. Cesk.gynek. 28 no.8:521-524 0 '63.

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dr. S. Stefanik.

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Obstetrical Hospital in Bratislava for the years 1951 through the
1st half of 1962. Česk.gynek. 28 no.8:525-529 O '63.

1. I. zen. a por. klin. Lek. fak. UK v Bratislave, prednosta prof.
dr. S. Stefanik.

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v Bratislavě (prednostat: prof. dr. S.Stefanik); Ved.lab.
param. Lek. fak. UK [University Komenskeho] v Bratislavě a
Ustav epid. a mikrob. Lek. fak. UK [University Komenskeho] v
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SAPAK, K.; SKLOVSKA, M.; PONTUCH, A.

Little known causes of premature labor. Cesk. gynek, 29
no.6s466-469 Ag '64.

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(prednosta prof. dr. S. Stefanik).

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Obstetrical surgery and perinatal mortality. Cesk. gynek.
29 no.6:534-545 Ag '64.

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v Bratislave (prednosta: prof. dr. S. Stefanik).

PONTUCH, ...; BRUCHAC, D.

Laboratory methods in gynecology and obstetrics. Introduction.
Cesk. gynek. 30 no.1:87-88 Mr'65.

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Menopausal endometrium in the histomorphologic and histochemical picture. Česk. gynek. 30 no.6:472-475 Ag '65.

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(prednosta prof. dr. S. Stefanik). Submitted January 7, 1965.

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Consultation services of allied disciplines in our clinical material. Cesk. gynek. 30 no.9:708-711 N '65.

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Remarks on the clinical value of the rat test. Cesk. gynak.
44 no.3:153-156 Apr'65.

1. I. gyn.-por. klinika Lekarske fakulty University Komenskeho
v Bratislave (prednosta: prof. dr. S. Stefanik).

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Long-term hospitalization in the prevention of premature pregnancy
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1. I. zenska a prodnicka klinika Lekarske fakulty Univerzity
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PONTUCH, F.; GAZAREK, F.; DRAC, P.; POKORNY, J.; UHER, M.; HRADECKY, L.; KOHOUTEK, M.; ZIDEK, J.; CECH, E.; CERVENKA, J.; NEMEC; NOVAKOVA, J.

Perinatal mortality in premature labor. Cesk. gynek. 29 no.6:459-466 Ag '64.

I. I. gyn.-por. klin. Lek. fak. University Komenskeho v Bratislave (prednosta prof. dr. S. Stefanik); Gyn.-por. klin. Lek. fak. Palackeho University v Olomouci (prednosta doc dr. F. Gazarek, CSc.); Gyn.-por. odd. Mestskeho ustavu narodniho zdravi v Brne (veduci MUDr. Nemec); I. gyn.-por. klin. Lek. Fak. University J.E. Purkyne v Brne (prednosta prof. dr. L. Havlasek [deceased]); II. gyn.-por. klin. Lek. fak. University J.E. Purkyne v Brne (prednosta doc. dr. M. Uher, CSc.); Gyn.-por. klin. Lek. fak. Karlovy University v Plzni (prednosta prof. dr. V. Mikolas); I. gyn.-por. klin. Fak. vseob. lek. Karlovy University v Prahe (prednosta prof. dr. K. Klaus, DrSc.); Gyn.-por. klin. Lek. fak. University P.J. Safarika v Kosiciach (prednosta doc. dr. K. Poradovsky, CSc.).

BELOV, N.D.; RAKHILIN, I.Ye.; ALESHIN, L.I.; SEREGIN, I.I.; FOGODIN,
A.I.; PONTIAR, A.A.; PETRUKHOV, P.I., red.

[Georgievskaya Highway with track pavement made of reinforced
concrete slabs in the Belozersk Logging Enterprise of Vologda
Province] Georgievskaya avtomobil'naia doroga s koleinym po-
krytiem iz zhelezobetonnykh plit v Belozerskom lespromkhoze
Vologodskoi oblasti. Vologda, Severo-Zapadnoe knizhnoe izd-vo,
1964. 36 p. (MIRA 18:5)

1. Nauchno-tehnicheskoye obshchestvo lesnoy promyshlennosti i
lesnogo khozyaystva. Vologodskoye oblastnoye pravleniye.
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Pontyar, Petrukhov).

PONTYOS, Odon, dr.

Consequences of gastroenteroanastomosis as an individual
operation in peptic ulcers. Magy. sebeszet 9 no.3:162-166 June 56

1. A Csornai Jarasi Tanacs Korhaza (igazgato: Keviczky Pa; dr.)
Sebeszeti Osztalyanak (Foorvos: Pontyos Odon dr.) kozlemenye.
(PEPTIC ULCER, surg.
gastroenteroanastomosis, postop. recur. & compl. (Hun))

MATOS, Lejos, dr.; PONTYOS, Odon, dr.; FILEP, Gyula, dr.

Prevention of vomiting after anesthesia with Dimenhydrinate (Deadalon).
Magy. sebeszet 14 no.6:394-398 D '61.

1. A Csornai Jarasi Tanacs Korhaza (Igazgato: Sik Laszlo dr.) Sebeszeti
Osztalyanak (Foorvos: Pontyos Odon dr.) kozlemenye.

(VOMITING ther) (DIMENHYDRINATE ther)
(ANESTHESIA compl)

PONUGAYEVA, A.G.; SLONIM, A.D., zaveduyushchiy.

Interrelationship of group and defensive responses to heat exchange. Trudy
Inst.fiziol. 1:134-140 '52. (MLR 6:8)

1. Laboratoriya ekologicheskoy fiziologii.
(Conditioned response) (Animal heat)

PONUGAYEVA, A.G.

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Zool. zhur. 33 no.4:869-875 J1-Ag '54. (MIRA 7:8)

1. Laboratoriya ekologicheskoy fiziologii Instituta fiziologii im. I.P.Pavlova.
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PONUGAYEVA, A.G.; TRUBITSYNA, G.A.

Changes in gas exchange in sheep. Trudy Inst.fiziol. 4:171-175 '55.

1.Laboratoriya ekologicheskoy fiziologii.Zaveduyushchiy A.D.Slonim.
(Sheep) (Respiration)

PONUGAYEVA, A.G.

Hole of the cheek pouches of the golden hamster in the gathering of food. Opyt. izuch. reg. fiziol. funk. 6:146-153 '63
(MIRA 17:3)

1. Laboratoriya ekologicheskoy fiziologii (zav. - prof. A.D. Slonim) Instituta fiziologii imeni Pavlova AN SSSR.

PONUGAYEVA, Antonina Gavrilovna; SLONIM, A.D., otv.red.; NATAROVA, N.V.,
red.izd-va; KRUGLIKOV, N.A., tekhn.red.

[Physiological studies of instincts in mammals] Fiziologicheskie
issledovaniia instinktov u mlekopitaiushchikh. Moskva, Izd-vo
Akad.nauk SSSR, 1960. 180 p. (MIRA 13:12)
(Instinct)

Ponukalin, A.

85-58-7-15/45

AUTHORS: Sokolov, P. Deputy Chief of the Saratovskiy aeroklub
(Saratov Aeroclub); and Ponukalin, A. Senior Pilot-Inspector,
Saratovskiy oblastnoy komitet DOSAAF (DOSAAF Oblast Committee)
(Saratov)

TITLE: High Achievements in Sports (Za vysokiye sportivnyye
dostizheniya)

PERIODICAL: Kryl'ya rodiny, 1958, Nr 7, p 11 (USSR)

ABSTRACT: The authors describe Komsomol and youth training for the Spartacus Games in Saratov. In the spring of 1958, more than 100 sportsmen were trained in gliding in the BRO-11 glider. Personalities mentioned include S.Safronov, Hero of the Soviet Union; Reserve officer P. Chepinoga, Hero of the Soviet Union; and pilot-instructors A. Kerkhon, A. Kokorin, Yu. Yegorov, V. Karshin, and Yu. Meshkov.

ASSOCIATION: Saratov Aeroclub and Saratovskaya oblast DOSAAF
Committee

Card 1/1 1. Sports--USSR 2. Gliders 3. Pilots--Training

REZNIKOV, V.M.; PONUROV, G.D.

Lignin extracted from Siberian spruce by the Bjorkman method.
Zhur. prikl. khim. 36 no.5:1068-1075 My '63. (MIRA 16:8)

1. Sibirskiy tekhnologicheskiy institut, g.Krasnoyarsk.
(Lignin) (Extraction (Chemistry))

KHOL'KIN, Yu.I.; PONUROV, G.D.

Chromatographic fraction of substances present in the products of
furfurol manufacture. Trudy Sib.tekh.inst. no.23:71-73 '59.
(MIRA 14:4)

(Furaldehyde)

(Chromatographic analysis)

SKRYNNIK, Vladimir Nikitovich; SOTNIKOV, Ya.I., ved. red.;
PONUROV, M.P., red.

[Design of automatic lines consisting of machine-tool units;
survey of foreign engineering] Proektirovaniye avtomaticheskikh
linii iz agregatnykh stankov; obzor zarubezhnoi tekhniki. Mo-
skva, TSentr. in-t tekhniko-ekon. informatsii, 1962. 98 p.
(MIRA 17:7)

REZNIKOV, V.M.; SVIDERIK, G.V.; LEVDIKOVA, V.L.; PONUROVA, G.D.

Ultraviolet spectra of condensed lignins. Zhur.prikl.khim. 36
no.6:1314-1322 Je '63. (MIRA 16:8)

1. Sibirskiy tekhnologicheskiy institut, g. Krasnoyarsk.
(Lignin—Spectra)

IOMUROVA, V. A.

"The Motility of Nerve Process and Its Development, by Training, in Rabbits, Dogs, and Lower Monkeys." Cand Biol Sci, Leningrad State Pedagogical Inst, Leningrad, 1953. (RZhBiol, No 1, Sep 54)

SO: Sum 432, 29 Mar 55